

Interrelated Water Management Plan Program Funds Application

Deadline for Applications August 28, 2006

Project Sponsor(s): North Platte Natural Resources District, U.S. Geological Survey, Conservation and Survey Division, Pathfinder Irrigation District, Farmers Irrigation District

Project Name: Characterization of Near-Surface Lithologies under Selected Irrigation Canals within the North Platte Valley, Western Nebraska, using Geophysical Methods

Total Amount Funds Requested from the Interrelated Water Management Plan Program Fund (IWMPPF): **\$ 1,192,896**

Years of funding requested (select one): **3**

Amount Requested from the Fund Year 1: **\$ 338,496**

Amount of Local Match Offered Year 1 (must equal at least 20% of funding requested from the IWMPPF): **\$ 200,000**

Contact - Name: Ron D. Cacek

Title: General Manager

Address: P.O. Box 36

Gering, NE 69341

Daytime Phone: 308-436-7111 **Fax:** 308-436-2456

E-mail: cacek@npnrd.org

Is this a continuation request for a project previously funded by the Commission? **NO**

Project Overview: In 300 words or less provide an overview of the project for which you seek funding. If you are asking the Natural Resources Commission to fund only a portion of the project, indicate the components for which you seek funding.

The scarcity of water supply in comparison to demand means that the available water needs to be managed carefully to optimize its use. Portions of the North Platte River Basin are designated by the State of Nebraska Department of Natural Resources (DNR) as over- appropriated. To support careful management in compliance with State Law, the North Platte Natural Resources District (NPNRD) and DNR, is developing an Integrated Management Plan for groundwater and surface water. A necessary

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component to this type of work is a clear understanding of the ground-water and surface-water systems to be managed and the development of management tools that will be used by the participating agencies and the public to manage ground-water recharge using leakage from irrigation canals.

The study area lies within the North Platte River valley upstream of Lewellen in the Nebraska panhandle. Within the valley, 27 irrigation districts operate canals delivering irrigation water to approximately 360,000 acres. Leakage from canals is a major source of ground-water recharge to aquifers. This recharge later discharges as base flow to streams creating an intricate combined ground water / surface-water flow system.

The Integrated Management Plan will use a suite of management tools to reduce consumptive water demands from overappropriated to fully appropriated level. To support the decision making process and to design a plan of using the canal systems as a method of delivering intentional groundwater recharge to the aquifer system, a ground water flow model is being developed (2006, Luckey). The U.S. Bureau of Reclamation has estimated that 40-50 percent of the water carried by the canals leaks through the canal bottom to become ground water recharge. Information on where this water is leaking preferentially will improve the recharge estimates for the model and provide critical insight into the relationship of ground water and surface water.

On behalf of the sponsor(s) named above, I hereby certify that the information contained in this application, including all attachments, is true, accurate and complete.

Authorized Signature of Natural Resources District

Title

Date

Typed or Printed Name of Authorized Signatory

Typed or Printed Title

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PROJECT DESCRIPTION

In ten pages or less, provide a discussion of your project using the topic areas and sequence listed below. Please refer to program guidelines to ensure that your project objectives and work products are clearly related to the priorities that will be used by the Commission in ranking.

- **Introduction**

Portions of the North Platte River Basin are designated by the State of Nebraska Department of Natural Resources (DNR) as being overappropriated. The scarcity of water supply in comparison to demand means that the available water needs to be managed carefully for the benefit of users within the North Platte River valley. To support careful management, and to comply with State Law, the North Platte Natural Resources District (NPNRD), in cooperation with the DNR, is developing an Integrated Management Plan for groundwater and surface water in the NPNRD. A necessary component to this type of work is a clear understanding of the ground-water and surface-water systems to be managed and the development of management tools that will be used by the participating agencies and the public to manage ground-water recharge using leakage from irrigation canals.

The area of study lies within the Nebraska portion of the North Platte River valley upstream of the town of Lewellen in the Nebraska Panhandle. Within the valley, 27 irrigation districts operate canals delivering irrigation water to approximately 360,000 acres (figure 1). Leakage from these canals is a major source of ground-water recharge for the area and in turn provides base flow to the valley streams creating an intricate combined ground-water / surface water flow system.

As part of the Integrated Management Plan, a three-dimensional numerical finite difference ground water flow model is being developed to evaluate the effectiveness of using leakage of water from selected irrigation canal systems to manage ground-water recharge (Luckey, 2006, oral communication). The U.S. Bureau of Reclamation estimates that canals in the area leak approximately 40-50 percent of their diversion into the aquifers (Verstratean and others, 2001). Information on where this water is

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leaking preferentially will improve the recharge estimates for the ground-water-flow model and provide critical insight into the relationship of ground water and surface water. The results of the ground-water model will provide information that will be an integral part to development of the Integrated Management Plan. In particular, there is a proposal to use the canal systems to regulate recharge to improve base flow to the streams. By using the model, policy makers and planners will be able to analyze the future impacts of such changes. This project is a continuation of the previous survey performed by Ball and others (2006) on the Interstate and Tri-State canals during 2004. The proposed study will use similar methods to characterize shallow lithology in areas not covered in previous studies. Survey work will map the main stems of the primary canals of the area and to evaluate the need for further survey.

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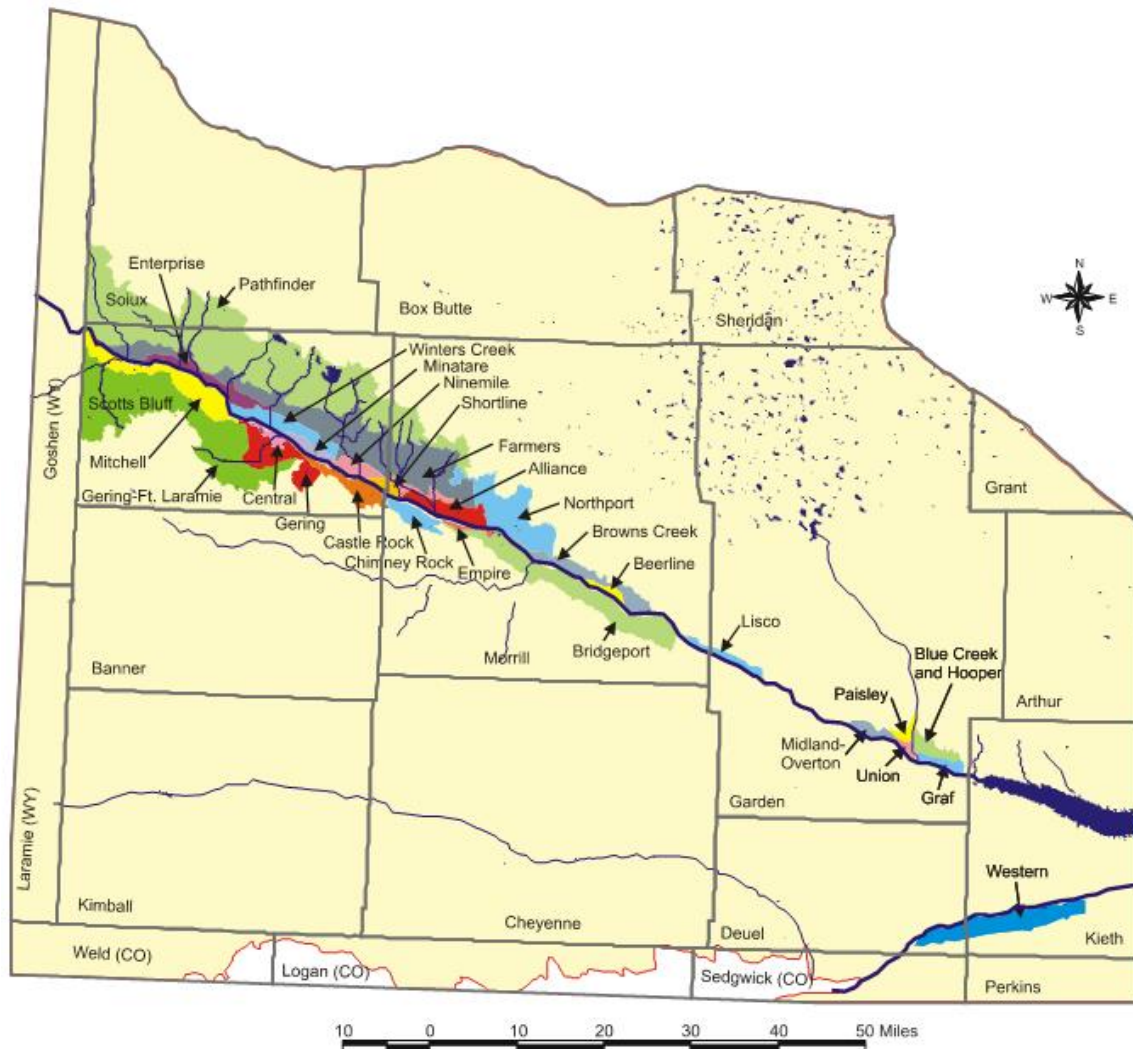


Figure 1 Location of surface water irrigation canals within the NPNRD

In order for the ground water flow model to accurately simulate current or future ground-water and surface-water conditions in the NPNRD, input of specific variables such as distribution of canal leakage is imperative. However, the values input into the model often are estimated based on lithologic data collected from boreholes that can be miles apart and miles from the canals. Moreover, these irrigation canals can and often do transect areas underlain by sand and gravel or clay deposits, which, in turn, can affect the volume of leakage. Because sand and gravel deposits allow water to move more quickly than clay deposits, it is likely that areas containing sand and gravel deposits incised by irrigation canals often will leak more than areas containing clay deposits. Further, because the input values of canal leakage are

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based on data collected from distant sites, these data may not be representative of actual conditions, which would lead to errors in the ground-water flow simulation.

The primary means of obtaining additional lithologic information within the canal systems has been through drilling of boreholes and examination of the boring logs, which is time consuming and expensive. The preferred approach would be to combine surface geophysical methods with a drilling program to provide a greater aerial coverage with fewer wells.

The U.S. Geological Survey (USGS), in cooperation with the NPNRD, University of Nebraska Lincoln Conservation and Survey Division, and the participating irrigation districts propose to use Direct Current (DC), Capacitively Coupled (CC) resistivity techniques through continuous resistivity profiling (CRP) and electro-magnetic (EM) methods, to map near-surface lithologies (five to seven meters). The lithologies of the near surface beneath the Interstate (Pathfinder), Gering-Fort Laramie, Mitchell, Gering, Enterprise, and Tri-State (Farmers) irrigation canals generally consist of sand, gravel, silt, or clay. These five canals were selected from the 27 irrigation canals in the North Platte valley to represent the variability of conditions in the study area due to their location, size, and irrigated area. Their relationship to the active North Platte valley flood plain, paleo-channels and terrace deposits where most of the saturated thickness exists was also a consideration. These data can help state and local water managers and scientists better understand the characteristics of the shallow subsurface (five to seven meters) underlying the irrigation canals so that the water resources can be managed more effectively.

- **Project Objectives**

The objectives of this study are to use EM, CC and DC CRP resistivity techniques to locate transmissive deposits that could be preferential areas for canal leakage. It is estimated that there will be approximately 350 miles of canals that serve approximately 200,000 acres that will be surveyed for this

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project. Additional work will include the measurement of canal leakage using fixed and portable acoustic sensors. There will also be geophysical measurements to map the wetted front of the recharge events in selected sections of the canals. In particular, this study will:

1. Identify lithologies within the shallow subsurface beneath the Interstate, Gering-Fort Laramie, Mitchell-Gering, Enterprise, and Tri-State irrigation canals using EM, CC, DC resistivity CRP surveys.
2. Create maps from the acquired lithologic datasets that will display zones of relative canal leakage potential along the surveyed sections of the canals.
3. Use the data from the surveyed canals to select sites for measuring the canal leakage using fixed and mobile acoustic measurement techniques.
4. Use the data from the surveyed canals to select sites for measurement of recharge rates by mapping the wetted front of the leakage in the subsurface by geophysical resistivity techniques.
5. Produce and publish a USGS Scientific Investigations Report of results.
6. Provide this data for use in future groundwater modeling efforts
7. Use this data to identify areas of interest for intentional groundwater recharge areas.

Project Tasks

Fluvial sediments display a wide range of resistivity values. Typically, finer-grained sediments such as clay are more electrically conductive; whereas coarser-grained sediments such as sand and gravel are more electrically resistive (Loke, 2003). Because coarse-grained sand and gravel deposits are more electrically resistive than silts and clays, resistivity methods can be used to map the extent of coarse-grain deposits. Coarse-grained deposits can be orders of magnitude more transmissive than fine-grain deposits (Driscoll, 1986). Within the North Platte River Valley, shallow sediments generally consist of Quaternary-age coarse-grain fluvial sediments deposited on the Tertiary siltstone and Cretaceous shale bedrock (Verstratean and others, 2001). The Cretaceous shale and Tertiary siltstones have low resistivity

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properties similar to fine-grain sediments and have good contrast from the coarse-grain sediments. This allows for an excellent contrast of the resistivity values as seen in the previous geophysical surveys of the area (Ball and others, 2006).

This study will use three surface geophysical resistivity techniques, DC, CC, and EM, to define the shallow subsurface lithologies in the selected canals. All data collected will be georeferenced using survey grade, real time kinematic (RTK) global positioning data collected concurrently with the geophysical measurements. The geophysical survey will take place on the irrigation canals during irrigation season. The focus of this data collection effort will be to survey areas not yet completed on these canals during the previous studies. Selected segments of canals will be surveyed using the appropriate method selected from those listed to best collect resistivity and EM data. The appropriate method will be selected based on the characteristics of the physical make up of the canals. All of the methods may be used in large wide canals, whereas either the CC CRP or EM method may be used in the smaller narrow canals. Approximately five percent of data in areas previously surveyed will be recollected for QA/QC purposes. This will allow for an evaluation of the repeatability of this technique.

Lithologic samples will be taken using a push technology sampler collecting continuous cores to a maximum depth of 10 meters in order to calibrate the collected geophysical data with actual lithologies at selected points. These samples will be described by a geologist in the field. All sample sites will be georeferenced using survey grade GPS for location. Post collection, samples will be analyzed for grain size and a split sample will be stored at the University of Nebraska Conservation and Survey Division sample warehouse and will become part of the county test-hole log books upon their revision.

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The NPNRD will use the interpretations from this investigation to refine ground- water models along the North Platte River. These ground-water models will provide results for planners and policy makers to use in the development of the Integrated Management Plan. The output of the model will allow for prediction of when, where, and at what volume water that is recharged from the canal system will return to the North Platte River and its tributaries. This will help water managers to estimate the effects on the water system of any changes in practices applied to surface- and ground-water use.

- **Project Timeline**

- Fall-Winter 2006-07

- Collect continuous cores from canal beds.

- Perform bench mark surveys for real time kinematic survey during geophysical survey.

- Complete planning for 2007 geophysical surveys

- Spring 2007

- Prepare sites for canal seepage loss estimates using side looker doppler acoustic methodology

- Prepare for geophysical surveys

- Complete lithologic analysis of core samples

- Summer 2007

- Perform geophysical CRP surveys

- Perform wetted front geophysical survey

- Complete initial analysis of collected data

- Begin report development

- Fall-Winter 2007-08

- Collect continuous cores from canal beds.

- Perform bench mark surveys for real time kinematic survey during geophysical survey.

- Complete planning for 2008 geophysical surveys

- Spring 2008

- Prepare sites for canal seepage loss estimates using side looker doppler acoustic methodology

- Prepare for geophysical surveys

- Complete lithologic analysis of core samples

- Summer 2008

- Perform geophysical CRP surveys

- Perform wetted front geophysical survey

- Complete initial analysis of collected data

- Continue report development

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Fall-Winter 2008-09

Collect continuous cores from canal beds.

Perform bench mark surveys for real time kinematic survey during geophysical survey.

Complete planning for 2009 geophysical surveys

Spring 2009

Prepare sites for canal seepage loss estimates using side looker doppler acoustic methodology

Prepare for geophysical surveys

Complete lithologic analysis of core samples

Summer 2009

Perform geophysical CRP surveys

Perform wetted front geophysical survey

Complete initial analysis of collected data

Continue report development

Fall-Winter 2009-10

Continue data analysis and report writing with completed report due May 2010

• **Partnerships**

The North Platte Natural Resources District in cooperation with the U.S. Geological Survey, UNL Conservation and Survey Division, Pathfinder Irrigation District, Farmers Irrigation District, Mitchell Irrigation District, Enterprise Irrigation District, Gering Ft. Laramie Irrigation District and Gering Irrigation District are all cooperating in this project. The NPNRD and the USGS are the only partners providing direct match to the Interrelated Water Management Plan Program Funds grant monies. The other partners are providing in kind match as labor and other services in the following estimated dollar amounts;

North Platte NRD	\$75,000
UNL Conservation and Survey Division	\$15,000
Pathfinder Irrigation District	\$5000
Farmers Irrigation District	\$5000
Gering Ft. Laramie Irrigation District	\$5000
Mitchell Irrigation District	\$2500
Enterprise Irrigation District	\$2000
<u>Gering Irrigation District</u>	<u>\$2000</u>
Total	\$111,500

• **Budget**

See following tables

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APPLICATION BUDGET SUMMARY

SUMMARY for All Years of Project

(If the project is for one year only, use this only page and delete the following budget pages)

Column A	Column B	Column C	Column D	Column E	Column F
Source of Funds ►	Interrelated Water Plan Program Funds	Local Match Funds	USGS Cooperative Funds		TOTALS ▼
Budget Category as it relates to activities described above ▼					
1.USGS Canal Leakage Study	1,192,896	600,000	316,393		2,109,289
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
TOTALS ►	1,192,896	600,000	316,393		2,109,289

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BUDGET YEAR: ONE

(This page is used by multi-year grants only. If your project is not a multi-year grant, then ignore or delete this page.)

Column A	Column B	Column C	Column D	Column E	Column F
Source of Funds ►	Interrelated Water Plan Program Funds	Local Match Funds	USGS Cooperative Funds		TOTALS ▼
Budget Category as it relates to activities described above ▼					
1. USGS Canal Leakage Study	338,496	200,000	95,029		633,525
2.					
3.					
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16.					
TOTALS ►	338,496	200,000	95,029		633,525

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BUDGET YEAR: TWO

(This page is used by multi-year grants only. If your project is not a multi-year grant, then ignore or delete this page.)

Column A	Column B	Column C	Column D	Column E	Column F
Source of Funds ►	Interrelated Water Plan Program Funds	Local Match Funds	USGS Cooperative Funds		TOTALS ▼
Budget Category as it relates to activities described above ▼					
1. USGS Canal Leakage Study	410,268	200,000	107,694		717,962
2.					
3.					
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16.					
TOTALS ►	410,268	200,000	107,694		717,962

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BUDGET YEAR: THREE

(This page is used by multi-year grants only. If your project is not a multi-year grant, then ignore or delete this page.)

Column A	Column B	Column C	Column D	Column E	Column F
Source of Funds ►	Interrelated Water Plan Program Funds	Local Match Funds	USGS Cooperative Funds		TOTALS ▼
Budget Category as it relates to activities described above ▼					
1. USGS Canal Leakage Study	444,132	200,000	113,670		757,802
2.					
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16.					
TOTALS ►	444,132	200,000	113,670		757,802

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1. Have other sources of funding not listed in the Budget Worksheet been approached for project support? If yes, name them and explain the outcome of your request.

It appears as non new budget in kind service to the entities named below. These partners are providing in kind match as labor and other services in the following estimated dollar amounts;

North Platte NRD	\$75,000
UNL Conservation and Survey Division	\$15,000
Pathfinder Irrigation District	\$5000
Farmers Irrigation District	\$5000
Gering Ft. Laramie Irrigation District	\$5000
Mitchell Irrigation District	\$2500
Enterprise Irrigation District	\$2000
Gering Irrigation District	\$2000
Total	\$111,500

2. Are all of the matching funds in the Budget Worksheet confirmed? If not, please identify those entities and list the date when confirmation is expected. Explain how you will implement the project if these sources do not confirm participation.

The only partner in the budget worksheet is the IWMPF dollars. If these dollars are not received the project partners will continue at a rate proportionate to the budget shortfall incurred to the original proposal. It will mean a longer time period to complete the survey, but the project partners are hopeful to complete this work as part of the integrated water management process. In particular, identification of areas of intentional groundwater recharge can be assessed for their effectiveness.

An electronic version of the grant application form and information on grant guidelines and timetable can be found on the Department of Natural Resources Web Site: <http://dnr.ne.gov>

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Application Submission:

1. One paper copy of the grant application with the required signatures is to be submitted by **August 28, 2006** to:

Jeremy Gehle
Nebraska Department of Natural Resource
301 Centennial Mall South
Lincoln, NE 68509-4676

2. One electronic copy is to be emailed by **August 28, 2006** to:

Jeremy Gehle at: jgehle@dnr.ne.gov